**Operation Manual**

# GuardShield™ Safe 4
# GuardShield™ Safe 4 PAC

## Safety Light Curtain

## Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (Publication SGI-1.1 available from your local Rockwell Automation sales office or online at http://literature.rockwellautomation.com/) describes some important differences between solid state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

| | |
|---|---|
| **WARNING** | Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss. |
| **IMPORTANT** | Identifies information that is critical for successful application and understanding of the product. |
| **ATTENTION** | Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequences. |
| **SHOCK HAZARD** | Labels may be on or inside the equipment (for example, drive or motor) to alert people that dangerous voltage may be present. |
| **BURN HAZARD** | Labels may be on or inside the equipment (for example, drive or motor) to alert people that surfaces may reach dangerous temperatures. |

## Conditions required for proper use of the GuardShield Safety Light Curtain

Please make sure you read and understand these requirements before you select and install the GuardShield safety light curtain. GuardShield safety light curtains are point of operation safeguarding devices. These safety light curtains are intended to be used to provide point of operation safeguarding of personnel on a variety of machinery.

The GuardShield family of safety light curtains are general purpose presence sensing devices which are designed to help protect personnel working on or near machinery.

The installation of the GuardShield safety light curtain must comply with all applicable federal, state and local rules, regulations, and codes.

It is the responsibility of the employer to properly install, operate and maintain the product as well as the machinery on which the GuardShield presence sensing device is installed.

GuardShield safety light curtains must be properly installed by qualified personnel.

GuardShield safety light curtains are presence sensing devices and will not protect personnel from heat, chemicals or flying parts. They are intended to signal a stop of hazardous machine motion when the sensing field is broken.

GuardShield safety light curtains can only be used on machinery which can be stopped anywhere in it's stroke or cycle.

GuardShield safety light curtains should never be used on full revolution clutched machinery.

The effectiveness of the GuardShield safety light curtains depend upon the integrity of the machine control circuit. The machinery that the GuardShield presence sensing device is installed should have control circuitry that is fail safe in design.

All stopping mechanisms for the machinery should be inspected regularly to provide proper operation. The protected machinery must have a consistent reliable and repeatable stopping time.

**ATTENTION!** Failure to read and follow these instructions can lead to misapplication or misuse of the GuardShield safety light curtains, resulting in personal injury and damage to equipment.

Allen-Bradley
GuardMaster®

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## 1. Approvals and Conformity

TÜV Rheinland Product Safety GmbH, performed the CE - type examination according to the machinery directive EC/98/37, appendix VI and the respective standards ICE 61496.

The CE - conformity declaration and the product approval certification (TÜV) is available at your nearest ROCKWELL AUTOMATION dealer or on the home-page www.Rockwell Automation.com.

All ROCKWELL AUTOMATION products are developed and manufactured following generally accepted rules in industry and in compliance with a total quality management system ISO 9001: 2000.

**ATTENTION**

GuardShield Safe 4 systems are only a safety protection device if all instructions in this manual and in the related documents are carefully followed and fully complied with. In addition the installer is responsible to comply with all local laws and standards.

**ATTENTION**

Failure to follow all instructions in this manual and related documents may lead to serious injury or death. Rockwell Automation cannot be held liable for any injury or death due to the negligence of the purchaser or installer.

**IMPORTANT**

This instruction manual is part of the light curtain GuardShield Safe 4. It must be kept accessible during the whole life cycle for everybody who is in charge of installation, operation, maintenance and safety control.

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## 2. Introduction

GuardShield Safe 4 safety light curtains are active optoelectronic protective equipment AOPE type 4 with object detection capability of 14 mm or 30 mm. GuardShield Safe 4 has built-in fully redundant self-monitoring circuitry and complies to annex VI of the European Machinery Directive EC/98/37 and IEC 61496 as a safety component. GuardShield Safe 4 is a control reliability device as well as defined in ANSI B11.19-1990, 5.5 and OSHA 29 CFR 1910.212.

### 2.1. System design

GuardShield Safe 4 light curtains consist of a transmitter and a receiver (*Figure 1*).
The transmitter as well as the receiver of GuardShield Safe 4 have a standard built-in intelligent laser alignment system ILAS.

This allows a much easier adjustment during installation and system testing compared to conventional safety light curtains. The ILAS may also be used as a vibration indicator at the installation.

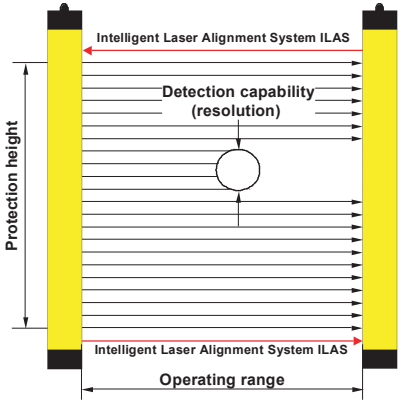



*Figure 1: Main system parameters*

The products are a modular construction housed in a very compact and sturdy extruded aluminium profile.

### 2.2. Special features

The outstanding features of the safety light curtain systems of the GuardShield Safe 4 are:

- ☑ Integrated laser alignment (ILAS)
- ☑ Max. 256 beams per system
- ☑ Finger (14 mm) and hand protection (30 mm)
- ☑ Large range with a compact profile type:
  14 mm resolution: 0 m to 6 m
  30 mm resolution: 0 m to 6 m
- ☑ Tolerant to dust, soiling, pollution
- ☑ Short circuit protected semiconductor outputs
- ☑ Built-in diagnostic LEDs
- ☑ Very compact design: 30 x 40 mm (1.2” x 1.6”)
- ☑ Optical synchronisation, no electrical cable needed between transmitter and receiver
- ☑ Maintenance-free and cost effective

## 3. Applications

### 3.1. Typical applications

GuardShield Safe 4 systems are used for (*Figure 2*):

- ☑ Entry / exit safeguarding
- ☑ Point-of-operation safeguarding
- ☑ Hazards area safeguarding
- ☑ Combination of entry and area safeguading
- ☑ Combination of entry, area and point-of-operation safeguarding

Typical areas of applications are:

- ☑ Robotic assembly line
- ☑ Welding robots
- ☑ Processing machinery
- ☑ Rotation machines
- ☑ Conveyor machines
- ☑ Automated paint shops
- ☑ Entry / exit of automatic storage facilities

Typical markets are:

- ☑ Automotive
- ☑ Apparatus
- ☑ Semi conductor industry
- ☑ Metal processing
- ☑ Paper processing
- ☑ Wood processing
- ☑ Glass manufacturing
- ☑ Textile industry.

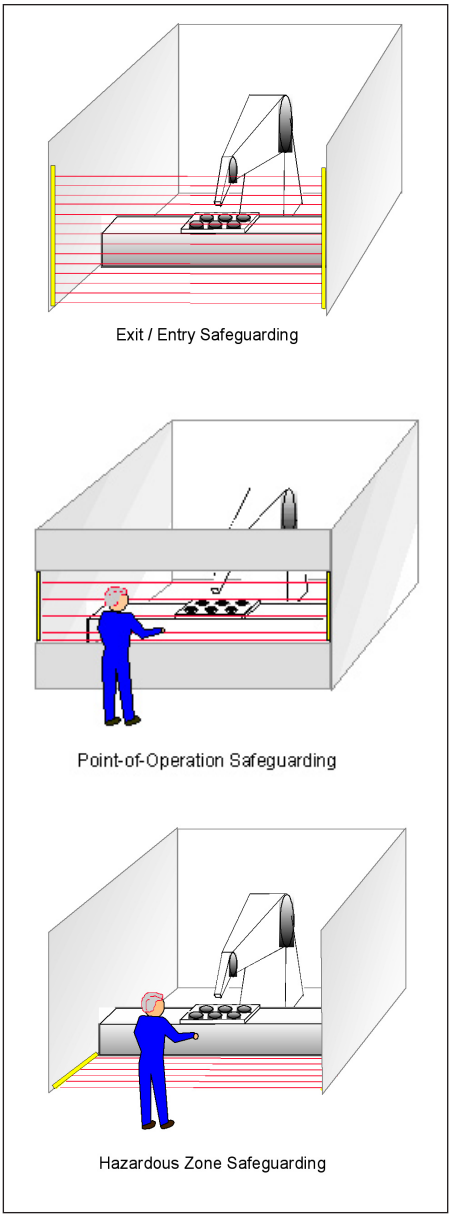



*Figure 2: Typical Applications*

### 3.2. Applications restrictions

GuardShield Safe 4 is not designed and approved for any application in explosive EX or radioactive areas.

### 3.3. Application conditions

The safe application of the light curtain system GuardShield Safe 4 needs certain precautions:

1. The control unit of the machine or system must be able to be electrically stopped and the stop time must be known.
2. The hazardous moving parts of the machine must always be stoppable and must achieve a safe position or complete standstill within the specified stop time of the machine.
3. When installing GuardShield Safe 4, the only way to access the hazard must be through the sensing field of the GuardShield Safe 4.

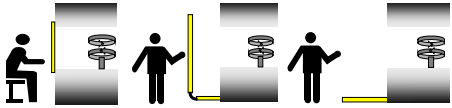


*Figure 3: Correct installation*

*Figure 4: Incorrect installation*

For the professional installation and connection, please consult the relevant laws and regulations. The safety officer of the manufacturing facilities, the local authorities (OSHA in USA, HSE in GB) or the respective industry associations as well as the intensively trained employees of ROCKWELL AUTOMATION are available for any safety related queries.

#### *3.3.1. Corner mirrors*

The protective field between transmitter and receiver can be guided around a corner using a mirror to allow safeguarding of two or three hazardous areas. Note that using one mirror will help reduce max. operating range by approx. 15 %.

It is not recommended to use more than two mirrors due to alignment difficulties that may occur.

As accessories two types of mirrors are available, with different mounting plates and sizes. Detailed information is available from ROCKWELL AUTOMATION.

## 4. Principles of operation

The transmitter sends coded infrared light pulses to the receiver, which evaluates them. If an object e.g. a finger (14 mm) or a hand (30 mm) penetrates the protective field, the fully redundant solid state Output Signal Switching Devices OSSD of the receiver switch off to stop the machine. As soon as the protective field is cleared, both outputs switch on again (automatic restart).

### 4.1. Mode of operation

GuardShield Safe 4 operates in the guard only mode with automatic restart. Other modes of operation e.g. PSDI mode (break mode), muting, external relay monitoring can be realized using external safety devices.

### 4.2. Intelligent Laser Alignment System ILAS

The ILAS is a most convenient feature to make alignment a pleasure. The ILAS can be activated at any time during installation or operation. It provides the possibility to check if the sensor is still perfectly aligned. In addition it indicates any vibrations at the mounting base.

### 4.3. LED indicators

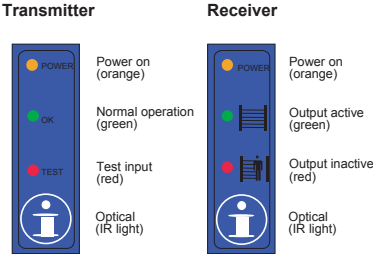



*Figure 5: LED Indicators*

### 4.4. Perimeter systems

Perimeter systems are usually produced by means of several single beam light barriers. But the flexibility of the GuardShield Safe 4 system allows also the production of vertical entry safeguarding according to the standard EN 999. Such systems are composed of active and passive elements in one compact profile. The active length of each is 120 mm.

The GuardShield Safe 4 PAC is a multiple beam safety light curtain designed for perimeter or access detection around hazardous machinery or equipment. The Safe 4 PAC is offered in 2 or 3 beam configurations with 360mm spacing between segments for a 2 beam pair and 360mm spacing for 3 beam pairs. Both the 2 and 3 beam Safe 4 PACs have a 30 meter operating range.
The clear front window of the Safe 4 PAC allows for easy identification of the active sensing modules and the Integrated Laser alignment system simplifies the alignment of the Safe 4 PAC in long range and complex applications.

The GuardShield Safe 4 PAC multi beam safety light curtain may be used as an optical electronic fence; detecting the presence of personnel as they pass through the sensing field or for safe guarding access to a hazardous area or machine process.

The protective field and the active elements respectively, are clearly recognized as black surfaces with the integrated optical lenses. The not monitored areas (passive elements) are also clearly indicated as yellow surfaces.

### 4.5. Muting

Muting of the GuardShield Safe 4 PAC is best accomplished by connecting the Safe 4 PAC to an MSR 42 multi function safety module. The MSR 42 allows two muting sensors to be connected for uni directional muting. The muting sensors can be positioned on the same side of the Safe 4 PAC in parallel for entry or exit end muting of a machine process. The two muting sensors may also be positioned in a crossed or X configuration for bi directional muting.
Rockwell Automation offers a number of muting solutions. Check with your local Rockwell Automation office or Rockwell Automation authorized distributor for muting application possibilities and muting application notes.

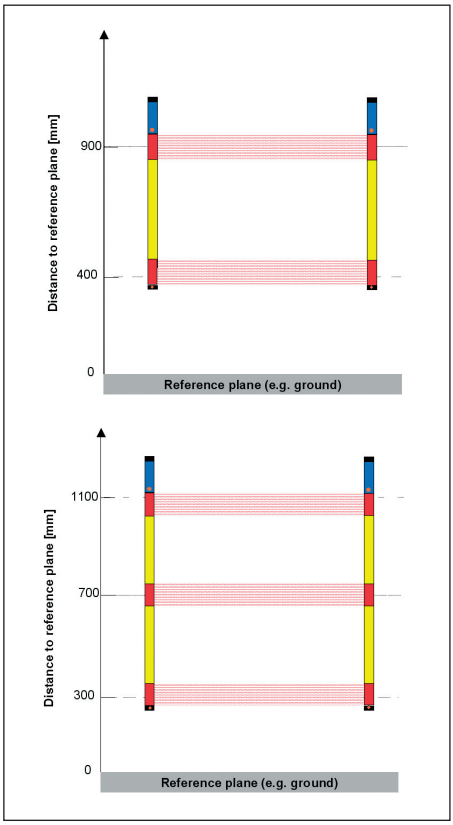



*Figure 6: Perimeter Systems (2 and 3 beams), accord. to EN999 (1998)*

## 5. Installation

### 5.1. Regulations and standards

The compliance with the fundamental health & safety requirements as detailed in the EU Machinery Directive EC/98/37 and control reliability according to OSHA 29 CFR 1910.212, ANSI B11.19 and ANSI B11.20 has to be achieved with the correct implementation of safety components. With the help of a hazard analysis as laid out in EN 292 and EN 1050, a comprehensive safety evaluation has to be made when designing and planning machinery and machinery control equipment. If Active Optoelectronic Protective Devices (AOPD) are used, the required safety distances, sufficient protective height and all application conditions must be considered during the planning phase.

#### *5.1.1. IEC Safety distance to danger point*

According to the standards, the GuardShield Safe 4 light curtain and the point of danger must be separated by a defined safety distance. This minimum distance safeguards that the danger point may only be reached after the hazardous motion has stopped. The safety distance (see also standards EN 294, EN 775, EN 811, EN 999) depends on

- Machine stop time
- Response time of the protective device (light curtain + safety relays)
- Resolution of the protective device
- Approaching speed to the danger point
- Position of the AOPD

The approaching speed is dependent on safety distance **S** as follows

S ≤ 500 mm, speed = 2 mm / ms
S > 500 mm, speed = 1.6 mm / ms

In cases of 'vertical' installation of the light curtains within an industrial environment and a resolution of the light curtain system **d**, (where 14 mm ≤ **d** ≤ 40 mm), the safety distance **S** to the point of danger is calculated according to the formula:

**For 100 mm ≤ S ≤ 500 mm:**
**S = 2 mm / ms x T + 8 x (d - 14)**

**For S > 500 mm**
**S = 1.6 mm / ms x T + 8 x (d - 14)**

S = Safety distance in mm
T = Total response time in ms (machine stop time + Safe2+ / Safe4 response time + safety relay response time)
d = Resolution of GuardShield Safe 4 in mm

In the case of perimeter systems (chapter 4.5) or light curtains with a resolution **d** > 40 mm the safety distance is calculated for vertical mounted light curtains and horizontal approach, according to the formula:

**S = 1.6 mm / ms x T + 850 [mm]**

More detailed information regarding safety distance and safety height can be found in EN 999 or EN 294, depending on mounting type of application.

#### *5.1.2 North American Safety Distance Formulas*

***US Safety Distance Formula***

**ATTENTION: The GuardShield safety light curtains must be mounted at a sufficient distance from the pinch point or point of operation hazard to help ensure that the machine stops before a person's finger, hand, arm(s), or body reaches the hazard.**

This distance, referred to as the safety distance, must be properly calculated prior to determining the safety light curtain protective height and mounting the light curtains on the machine. Failure to properly calculate this safety distance may result in operator injury.

**IMPORTANT**: Regardless of the calculated safety distance, GuardShield safety light curtains should never be mounted closer than six inches from the point of operation or pinch point hazard.

In the United States there are two formulas that are used to properly calculate the safety distance. The first, the OSHA formula, is the minimum requirement for the calculation of the safety distance. The second formula, the one recommended by Rockwell Automation, is the ANSI formula, which incorporates additional factors to be considered when calculating the safety distance.

**OSHA Safety Distance Calculation Formula**

The OSHA safety distance formula as specified in CFR Subpart O 1910.217 is as follows:

$$Ds = 63 \times T_S$$

$D_s$ Safety Distance

63 Is the OSHA recommended hand speed constant in inches per second

$T_S$ Is the total stop time of all devices in the safety circuit, measured in seconds. This value must include all components involved in stopping the hazardous motion of the machinery. For a mechanical power press it is the stopping time measured at approximately the 90º position of the crankshaft rotation.

Note: The $T_S$ number must include the response times of all devices, including the response time of the safety light curtain, the safety light curtain controller (if used), the machine's control circuit and any other devices that react to stop the hazardous motion of the machinery. Not including the response time of a device or devices in the stop time calculation will result in insufficient safety distance for the application. This may result in operator injury.

**The ANSI Safety Distance Formula**

The ANSI safety distance formula, which is the Rockwell Automation recommended formula, is as follows:

$$D_S = K \times (T_S + T_C + T_r + T^{bm}) + D_{pf}$$

$D_s$ Minimum safety distance between the safe guarding device and the nearest point of operation hazard, in inches.

K Hand speed constant in inches per second. The ANSI standard value is 63 inches per second when the operator begins reaching toward the point of operation hazard from rest. NOTE: ANSI B11.19 1990 E4.2.3.3.5 states "The value of the hand speed constant, K, has been determined by various studies and although these studies indicate speeds of 63 inches/second to over 100 inches/second, they are not conclusive determinations. The employer should consider all factors, including the physical ability of the operator, when determining the value of K to be used."

$T_s$ Stop time of the machine tool measured at the final control element.

$T_c$ Response time of the control system.

**Note**: $T_S$ and $T_C$ are usually measured by a stop time measuring device.

$T_r$ Response time of the presence sensing device (safety light curtain) and its interface, if any. This value is generally stated by the device manufacturer or it can be measured by the user.

$T_{bm}$ Additional time allowed for the brake monitor to compensate for variations in normal stopping time.

$D_{pf}$ Depth penetration factor. It is an added distance to allow for how far into the protective field an object, such as a finger or hand, can travel before being detected. $D_{pf}$ is related to the safety light curtain's object sensitivity. Object sensitivity is the smallest diameter object which will always be detected anywhere in the sensing field.

### *5.1.3. Height of protective field*

The protective field is clearly visible as the black area with the optical lenses on the transmitter and receiver.

In addition the height of the protective field A is found on the label of each system and in the selection tables, described in chapter 8.2 (resolution 14 and 30 mm).

**ATTENTION**

The laser beams of the ILAS are not part of the protective field.

Use only the protective field as mentioned on the product label. Otherwise serious injury or death may occur.

### *5.1.4. Response time – light curtain*

The response time $t_R$ is found on the product label, or from the selection tables 8.2.

#### *5.1.5. Distance to reflective surfaces*

Reflective surfaces may cause reflections within the transmitter and receiver aperture angle, i.e. an interruption of the protective field would not be recognized (*Figure 7*).

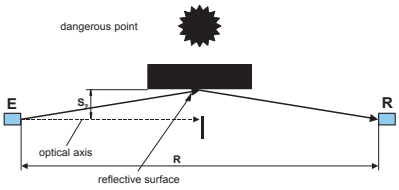



*Figure 7: Distance to reflective surfaces*

Should reflective surfaces arise, i.e. aluminium container passing near the light curtain or if the danger point itself is reflective, i.e. a steel blade, the safety distance $S_2$ must be increased, such that no reflective surface lies within the distance $S_2$.
The increase of the safety distance is dependant of the actual operation range R according to IEC 61496 and may be calculated as follows:

| Safe4 | |
|---|---|
| **S2 = 72 mm** | **for R < 3 m** |
| **S2 = R x 0.0219** | **for R ≥ 3 m** |

#### *5.1.6. Multiple light curtain arrangement*

When using several optoelectronic safety devices in the same application, the systems should be installed in such a way that they cannot interfere with each other. Care must be taken that each receiver only receives light from its own transmitter (*Figure 8*).

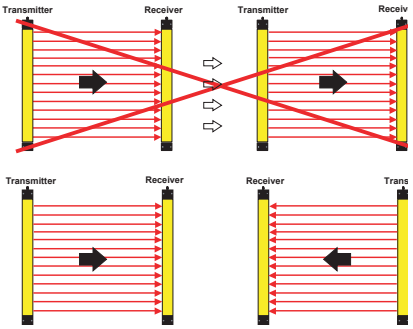



*Figure 8: Multiple light curtain arrangement*

The safety light curtain has been thoroughly tested against light interferences according to the stringent requirements of IEC 61496. Nevertheless any direct interference into the receiver with other infrared sources like through beam photoelectric sensors, laser scanner, transmitters etc. should be avoided.

### 5.2. Mechanical installation

Be aware that a rigid, flat base, isolated against shock and vibration should be selected to mount the GuardShield Safe 4. This in combination with the standard mounting brackets set will keep the initial alignment during operation even in harsh industrial environments.

#### *5.2.1. Mounting brackets*

The backside of the light curtain profile has continuous grooves to attach the mounting brackets at any position along the light curtain housing (*Figure 18*).

Each system is delivered with four mounting brackets.

Optional available mounting brackets (*Figure 9*):

- Vertical mounting brackets for mounting the light curtain in the vertical axis of the light curtain. (± 4º adjustable)
- POC and SICK FGS mounting profiles (not adjustable

The mounting brackets contain all necessary mounting parts and a separate instruction sheet to help ensure that the parts are assembled properly.

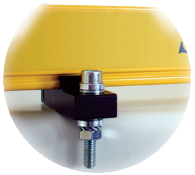
#### *5.2.2. Intelligent Laser Alignment System ILAS*

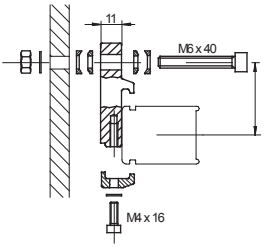
**WARNING: Class 2 Laser**
Do not expose your eyes to the laser beam to prevent exposure to dangerous radiation!
Turn **ILAS** off if not used!

**To switch on ILAS**:
- Touch the hand symbol ☞

**Operation**: Laser beam is blinking

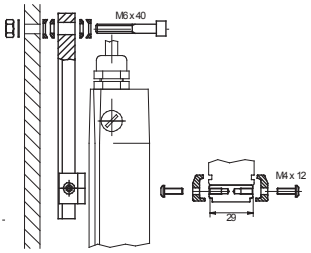
**To switch off ILAS**:
- Touch the hand symbol ☞ again
- Automatically after 5 minutes





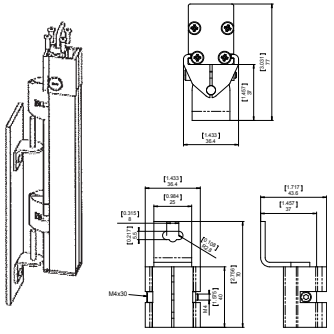

**445L-AF6140**
**Standard mounting brackets**

- For side mounting
- Adjustable by ± 4°




**445L-AF6144**
**Vertical mounting brackets (optional)**

- For mounting in the vertical axis of the light curtain
- Adjustable by ± 4°



**445L-AF6141**
180° Mounting, rotation ± 90°, for applications where the mounting angle is not set using the mounting frame.
(2 brackets per kit)

*Figure 9: Different mounting brackets for a GuardShield Safe 4*

### *5.2.3. Adjustment Procedure without ILAS*

1. Mount the transmitter and the receiver with the adjustable mounting brackets. Make sure that the longitudinal axis of both are oriented parallel. A spirit level might help to find the correct position.
2. Take care that the receiver and transmitter are oriented in the same direction. This means, the controllers of the transmitter and receiver have to be at the same end of the protective field.
   It is not allowed to mount GuardShield Safe 4 systems turned by 180° (*Figure 10*)

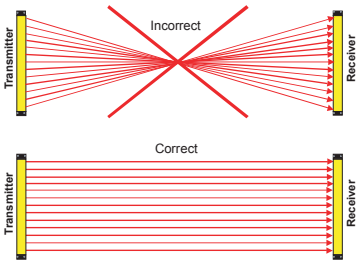



*Figure 10: Layout of the transmitter / receiver*

3. After aligning the longitudinal axis of transmitter and receiver, rotate the receiver around the longitudinal axis to find the receiving angle. During rotation, the receiving angle is shown when the green LED of the receiver controller is on.
4. Adjust the receiver to the centre point of the operating angle, and tighten.
5. After aligning the receiver rotate the transmitter to find the emitting angle. During rotation, the emitting angle is shown when the green LED of the transmitter controller is on.
6. Adjust the transmitter to the centre point of the operating angle, and tighten.
7. Control the operation of the GuardShield Safe 4 light curtain by using the test rod (*Figure 12*). Introducing the test rod into the protective field at any position must lead to a protective field interruption (shining of the red LED on the receiver).

When mounting Perimeter Systems adjust the heights according to the recommendations in the relevant standard, i.e, EN 999, ANSI/RIA 15.06 etc.

### *5.2.4. Adjustment Procedure with ILAS*

1. Mount the transmitter and the receiver with the adjustable mounting brackets. Look for that the longitudinal axis of both are oriented parallel. Take care that receiver and transmitter are oriented in the same direction. This means, the controllers of transmitter and receiver have to be at the same end of the protective field. It is not allowed to mount GuardShield Safe 4 systems turned by 180° (*Figure 10*).
2. The ILAS is activated by touching the hand symbol ☞ at the transmitter and at the receiver.
3. Adjust the transmitter and receiver in a way that both laser points hit the laser target on the opposite unit. Small deviations are harmless as long as they are within the aperture angle.
4. Tighten all screws firmly.
5. Switch the ILAS off when aligned.
6. Control the operation of the light curtain by using the test rod (*Figure 12*). Introducing the test rod into the protective field at any position must lead to a protective field interruption (shining of the red LED on the receiver).

### *5.2.5. Remarks to ILAS*

Due to dimensional tolerances the red ILAS light spot deflects from the target center when the light curtain is aligned optimally in the center of the operating range. The optimal operating point can be found after alignment with ILAS (chapter 5.2.4) when moving the axis in X- (left, right) and Z- (up, down) direction. The optimal operating point is in the middle of the two end points, where the receiver output switches from active to inactive condition.

On optimal alignment of the light curtain the ILAS light point can deflect from the ILAS target point. The maximum deflection adds up to the following value due the operating distance:

| | | |
|---|---|---|
| 2 m | R = 7 mm | D = 7 mm |
| 6 m | R = 20 mm | D = 21 mm |
| 9 m | R = 30 mm | D = 32 mm |
| 18 m | R = 60 mm | D = 63 mm |
| 30 m | R = 99 mm | D = 105 mm |

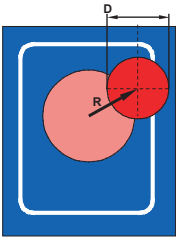



*Figure 11: Adjustment with ILAS*

### *5.2.6. Testing the protection field*

After Installation and Alignment of the GuardShield Safe 4 safety light curtain, the protection field has to be tested with the test rod for the corresponding resolution (14 or 30 mm) according *Figure 12*.

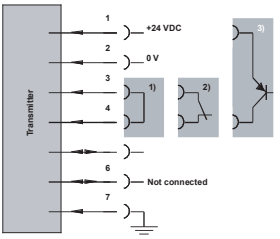
*Figure 12: Correct testing of the protective field using a test rod*

## 5.3. Electrical Installation

### *5.3.1. Connection diagram*

The transmitter and receiver are connected to the machine control using a 5-wire cable.

For the transmitter and the receiver two M12 (for cable - Ø 3 ... 6.5 mm) are supplied.



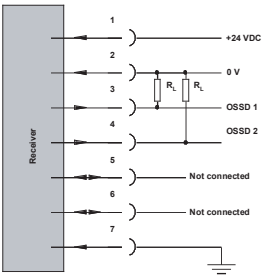




*Figure 13: Terminal block connection (see also Figure 18)*

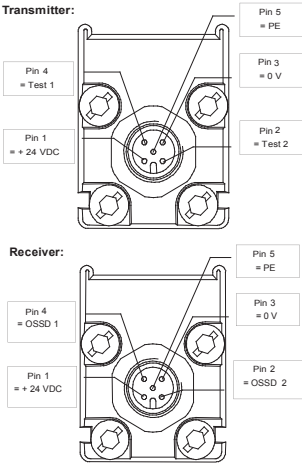



*Figure 14: M12/5 Pin connector*

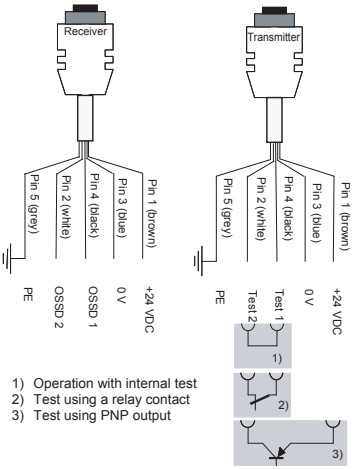



*Figure 15: Wiring of the connecting cables of the M12/5 Pin connector*

Transmitter and receiver are supplied with M12/5 pin connectors. The wiring of such connecting plugs is given in *Figure 14* and *Figure 15*.

### *5.3.2. Test input to transmitter*

Normally the test input at the transmitter is installed with a short circuit jumper to activate the transmitter. If an external test is desired, a contact can be connected to the test input (*Figure 13*).

The following points have to be considered:

- In case of operation in the modus “self monitoring” both OSSD outputs have to be connected separately to the safety switching of the machine.

The timing of test input is as follows (*Figure 16*):

| | Time | Value in ms |
|---|---|---|
| Response time on test signal | $t_1$ | ≤ $t_R$ + 15 |
| Time to test | $t_2$ | > $t_1$ |
| Restart time after test | $t_3$ | ≤ 800 |

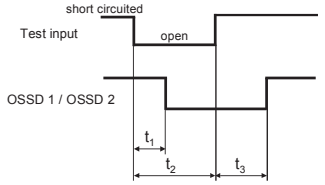



*Figure 16: Test timing diagram*

$t_R$ means the response time of the respective GuardShield Safe 4 type (see product label).

| Internal test | Description | Value |
|---|---|---|
| Continuous test current | I | 10 mA |
| Peak test current | $I_P$ | 100 mA |
| Time of peak test current | $t_P$ | 20 µs |

| Internal test | Transmitter | Test LED Transmitter |
|---|---|---|
| Short circuited (closed) | Active | Green |
| Open | Inactive | Red |

### *5.3.3. Power supply*

GuardShield Safe 4 are devices of electrical safety level III (extra low voltage). 24 VDC ± 20 % has to be supplied by a power supply that complies with IEC / EN 60204 and IEC / EN 60742. Such a power supply meets the electrical safety requirements and maintains the minimum power of 18 VDC during 20 ms even in the event of voltage dips

### *5.3.4. Bringing into operation*

After the power has been applied to the GuardShield Safe 4 and the automatic power-up test is successfully completed (power up test time < 3 s) the green LED on the receiver and transmitter will light on. The system is now ready to operate.
The automatic power-up test will only be successful, if the transmitter and receiver are properly aligned, correctly connected and the protective field is not interrupted.
Any intrusion of an object into the protective field will switch the OSSD off within the specified response time and the LED at the receiver toggles from green to red.

### *5.3.5. Outputs*

The two redundant Output Signal Switching Devices (OSSD) are fully monitored. Any short circuits are detected. The maximum load is 0.4 A, higher currents are limited through short circuit protection. Increased output loads may be realized using external safety interfaces.

⚠ **Important information:**
Safety devices for connection of GuardShield Safe 4 must be built with PNP logic. The outputs will be periodically controlled for short-circuit and cross-fault detection.

The output voltage at the solid-state outputs is dependant on the power supply and the output load (see chapter 11 Technical Data).

### *5.3.6. Trouble shooting*

Possible errors and operation status are indicated with the LED indicators on the transmitter and receiver.

Following combinations are relevant:

*Table 1: Transmitter*

| Status | LED | | |
|---|---|---|---|
| | **Orange** (Power) | **Green** (ok) | **Red** (Test) |
| No power supply (external) | off | off | on |
| Test input closed (external) | on | on | off |
| Test input open (external) | on | off | on |
| Controller error (internal) | flashing | off | on |
| Protective field error (internal) | flashing | off | flashing |

*Table 2: Receiver*

| Status | LED | | |
|---|---|---|---|
| | **Orange** (Power) | **Green** (Protective field not interrupted) | **Red** (Protective field interrupted) |
| No power supply (external) | off | off | off |
| No sufficient power (external) | on | off | off |
| OSSD on (on-load operation, protective field not interrupted, normal) | on | on | off |
| OSSD off (off-load operation, protective field interrupted or insufficient alignment of the system) | flashing | off | on |
| OSSD error (external, short circuit between OSSD 1 and OSSD 2, towards 0 V and off 24 VDC) | all 3s short time | off | flashing |
| Controller error (internal) | irregular flashing | off | on |
| Protective field error (internal) | flashing | off | flashing |

**External error**: An external interface error can be resolved by correcting the installation, due to

1. Receiver: short circuit of both OSSDs, of OSSD to $U_{sp}$, of OSSD to GND
2. Transmitter: Test input open
3. None or too low power supply
4. Inadequate adjustment of transmitter and receiver

**Internal error** (orange LED is irregularly flashing):
Please contact the nearest ROCKWELL AUTOMATION representative.

**Normal operation**

| Transmitter | Receiver | Operation status |
|---|---|---|
| Test input closed | OSSD on | Protective field free |
| Test input closed | OSSD off | Protective field interrupted |
| Test input open | OSSD off | Test active |

## 6. Interfacing to safety devices

The interfacing of the light curtain with the machine control has to be control reliability, i.e. a correct interface with a safety PLC or safety relays with positive guided relay contacts.

*Figure 17* - Diagram for automatic reset mode - shows a diagram of a typical emergency stop relay component.

Other applications are mentioned in the application note “Safety Interfaces with GuardShield Safe 4”, on the ROCKWELL AUTOMATION homepage.

**ATTENTION**

The safety devices and the interconnection to the machinery have to comply with the basic safety requirements as mentioned in the current regulations and standards.

Direct interfacing of a safety light curtain to machine control that does not meet the necessary safety integrity level, i.e. use of general purpose PLCs or general purpose relays can cause serious injury or death of persons.

***If necessary, consult a professional safety engineer!***

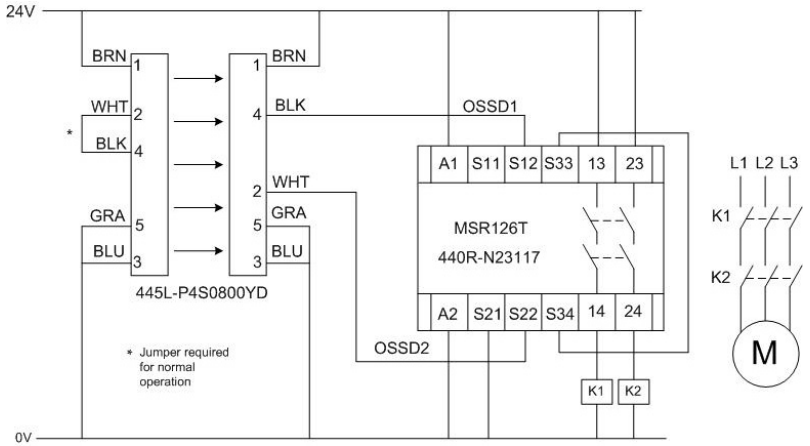



*Figure 17: Safe 4 or Safe 4 PAC for Automatic Reset mode using MSR 126T safety relay module*

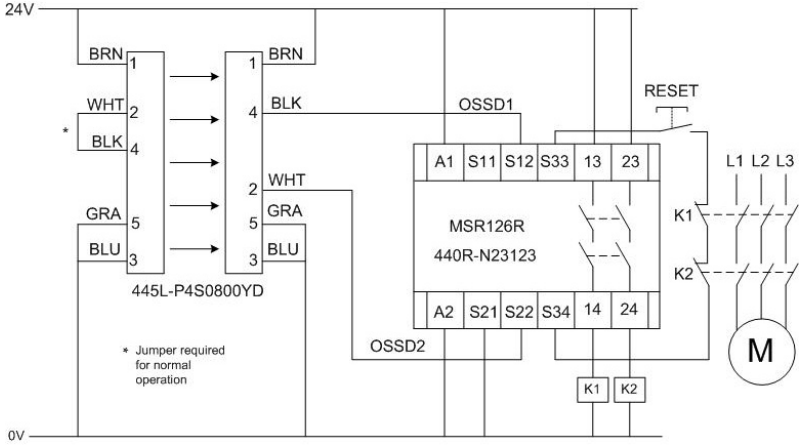



*Figure 18: Safe 4 or Safe 4 PAC for Monitored Manual Reset mode using MSR 126R safety relay module*

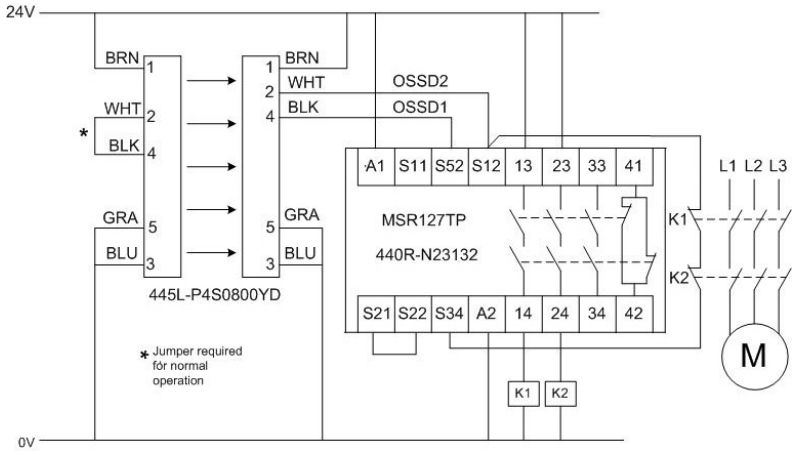



*Figure 19: Safe 4 or Safe 4 PAC for Automatic Reset mode using MSR 127TP safety relay module*

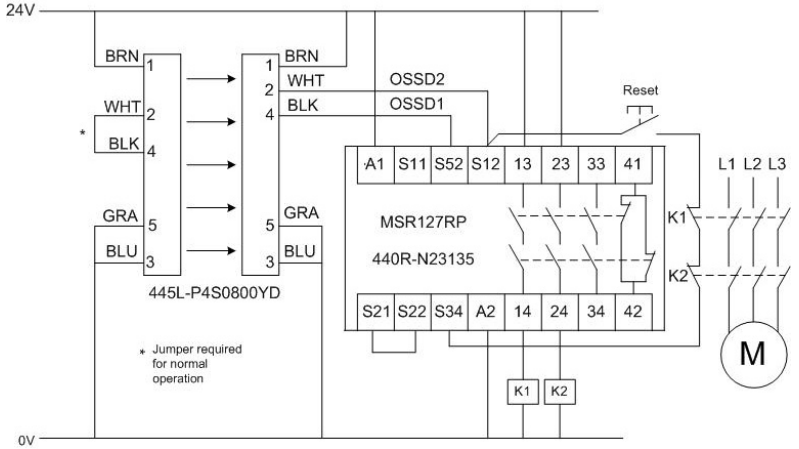



*Figure 20: Safe 4 or Safe 4 PAC for Monitored Manual Reset mode using MSR 127RP safety relay module*

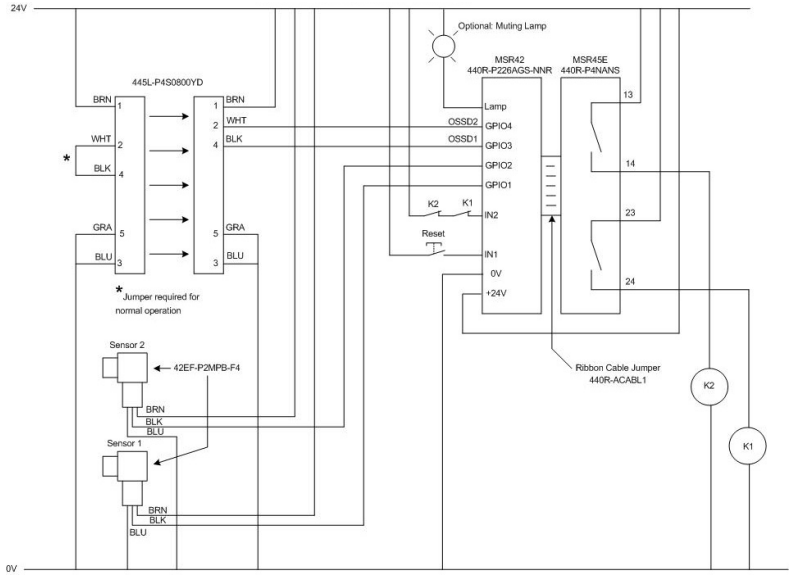



*Figure 21: Safe 4 or Safe 4 PAC for Two Sensor Muting using MSR 42 multi-function safety module and MSR 45 E safety relay expansion module*

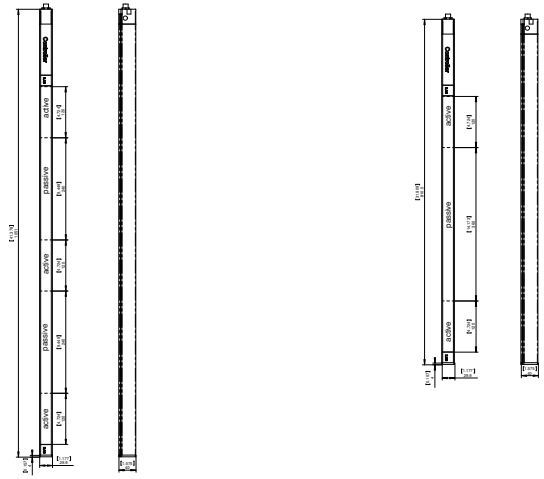



*Figure 22: Safe 4 PAC - 2 and 3 passive elements*

## 7. Dimensional drawings

### 7.1. System with integrated controller component

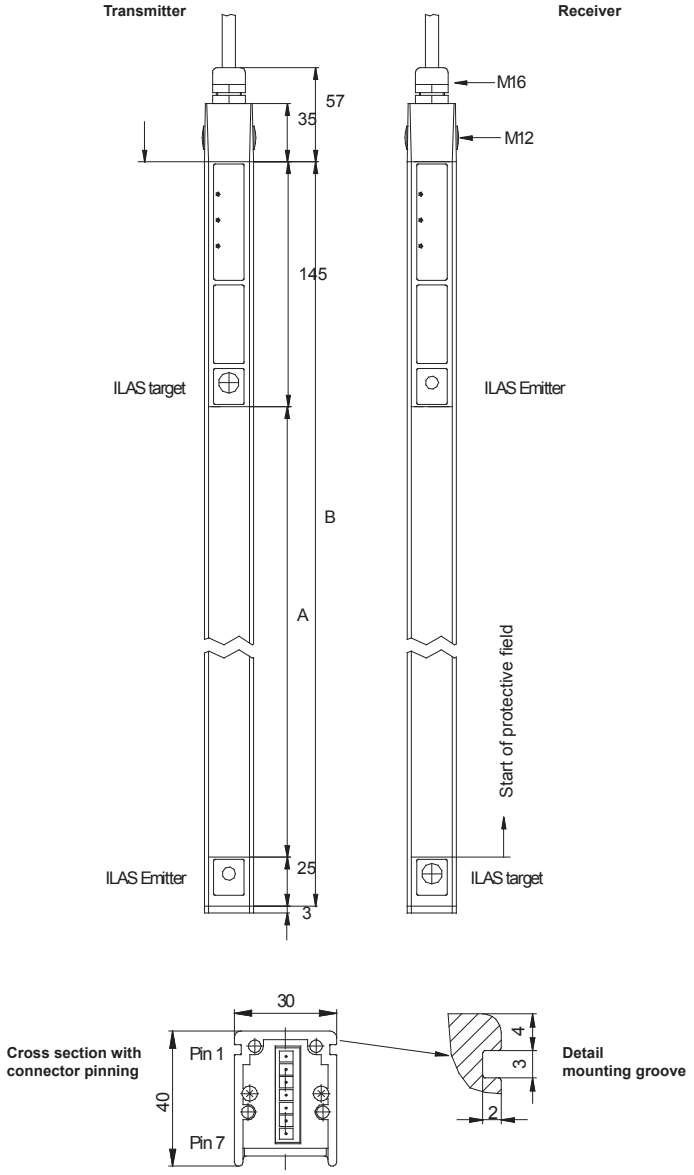



*Figure 23: Dimensional drawing, cross Section with Pin-out of connector*

## 8. Selection of a safety light curtain

### 8.1. Check list

In consideration of following points the selection of a proper GuardShield Safe 4 safety light curtain will be simplified:

1. **Regulations**
   Look up carefully the actual regulations and codes applicable to the particular application in your country. Local authorities and professional organisations as well as ROCKWELL AUTOMATION representatives will provide necessary assistance.
   USA: Occupation Safety and Health Administration OSHA, others like ANSI, RIA and further professional organisations
   GB: Health and Safety Executive HSE, safety con-sultants and professional organisations.

2. **Protective field**
   Determination of
   - required operating range,
   - protective height (available in increments of 120 mm),
   - resolution (object detection capability: 14 mm or 30 mm)

   Operating range and protective height must be chosen so that the danger points are only accessible through the protective field.

3. **Response time**
   The response time $t_{R\text{-}BWS}$ of a GuardShield Safe 4 can be found on the product label and in the selection table (next section).

4. **Corner mirrors**
   Using corner mirrors allows safeguarding of two or three protective fields with one light curtain. Each corner mirror helps reduce the operating range by approximately 15 % per mirror.

### 8.2. Selection table

*Table 3: 14 mm resolution with ILAS*

| Catalog No. | Protective height A (mm) | Total length B (mm) | Response time $t_R$ (ms) | Max. range (m) | Resolution (mm) | Weight per pair (kg) |
|---|---|---|---|---|---|---|
| 445L-P4L0120YD | 120 | 290 | 10.5 | 6 | 14 | 1.0 |
| 445L-P4L0240YD | 240 | 410 | 15.8 | 6 | 14 | 1.4 |
| 445L-P4L0360YD | 360 | 530 | 21.1 | 6 | 14 | 1.8 |
| 445L-P4L0480YD | 480 | 650 | 26.3 | 6 | 14 | 2.2 |
| 445L-P4L0600YD | 600 | 771 | 31.6 | 6 | 14 | 2.6 |
| 445L-P4L0720YD | 720 | 891 | 36.9 | 6 | 14 | 3.0 |
| 445L-P4L0840YD | 840 | 1’011 | 42.2 | 6 | 14 | 3.5 |
| 445L-P4L0960YD | 960 | 1’131 | 47.5 | 6 | 14 | 4.0 |
| 445L-P4L1080YD | 1’080 | 1’252 | 52.8 | 6 | 14 | 4.0 |
| 445L-P4L1200YD | 1’200 | 1’372 | 58.1 | 6 | 14 | 4.5 |
| 445L-P4L1320YD | 1320 | 1492 | 63.4 | 6 | 14 | 5.0 |
| 445L-P4L1440YD | 1440 | 1612 | 68.7 | 6 | 14 | 5.5 |
| 445L-P4L1560YD | 1560 | 1733 | 74.0 | 6 | 14 | 6.0 |
| 445L-P4L1680YD | 1680 | 1853 | 79.3 | 6 | 14 | 6.5 |
| 445L-P4L1800YD | 1800 | 1973 | 84.6 | 6 | 14 | 7.0 |
| 445L-P4L1920YD | 1920 | 2145 | 89.9 | 6 | 14 | 7.5 |

*Table 4: 30 mm resolution with ILAS*

| Catalog No. | Protective height A (mm) | Total length B (mm) | Response time $t_R$ (ms) | Max. range (m) | Resolution (mm) | Weight per pair (kg) |
|---|---|---|---|---|---|---|
| 445L-P4S0120YD | 120 | 290 | 7.8 | 6 | 30 | 1.0 |
| 445L-P4S0240YD | 240 | 410 | 10.5 | 6 | 30 | 1.4 |
| 445L-P4S0360YD | 360 | 530 | 13.1 | 6 | 30 | 1.8 |
| 445L-P4S0480YD | 480 | 650 | 15.8 | 6 | 30 | 2.2 |
| 445L-P4S0600YD | 600 | 771 | 18.4 | 6 | 30 | 2.6 |
| 445L-P4S0720YD | 720 | 891 | 21.1 | 6 | 30 | 3.0 |
| 445L-P4S0840YD | 840 | 1'011 | 23.7 | 6 | 30 | 3.5 |
| 445L-P4S0960YD | 960 | 1'131 | 26.3 | 6 | 30 | 4.0 |
| 445L-P4S1080YD | 1'080 | 1'252 | 29.9 | 6 | 30 | 4.0 |
| 445L-P4S1200YD | 1'200 | 1'372 | 31.6 | 6 | 30 | 4.5 |
| 445L-P4S1320YD | 1'320 | 1'492 | 34.3 | 6 | 30 | 5.0 |
| 445L-P4S1440YD | 1'440 | 1'612 | 36.9 | 6 | 30 | 5.5 |
| 445L-P4S1560YD | 1'560 | 1'733 | 39.6 | 6 | 30 | 6.0 |
| 445L-P4S1680YD | 1'680 | 1'853 | 42.2 | 6 | 30 | 6.5 |
| 445L-P4S1800YD | 1'800 | 1'973 | 44.9 | 6 | 30 | 7.0 |
| 445L-P4S1920YD | 1920 | 2'093 | 47.6 | 6 | 30 | 7.5 |

*Table 5: Safe 4 PAC with ILAS*

| Safe 4 PAC Part Numbers | | | | | | | |
|---|---|---|---|---|---|---|---|
| Catalog No. | Protective height mm (in) | Total length mm (in) | Response time $t_R$ (ms) | Max. range (m) | Beam Spacing mm (in) | Number of Beams | Weight per pair (kg) |
| 445L-P4S2500YD | 600 (23.6 ) | 811(31.9) | <_ 10.5 | 30 | 500 (19.7) | 2 | 4 |
| 445L-P4S3400YD | 840 (33.0) | 1051 (41.4) | <_ 13.1 | 30 | 400 (15.7) | 3 | 4.5 |

For further information, dimensional drawings in different file formats are available on our ROCKWELL AUTOMATION homepage.

### 8.3. Accessories / Components

*Table 6 - Corner Mirror*

| GuardShield Safe 2 / Safe 4 Protective Height (mm) | Narrow Corner Mirror, short range 0...4M | Catalog Number | Wide Corner Mirror, Long range 4...15M | Catalog Number |
|---|---|---|---|---|
| 120 / 240 | | 440L-AM0750300 | | 440L-AM1250300 |
| 360 | | 440L-AM0750450 | | 440L-AM1250450 |
| 480 | | 440L-AM0750600 | | 440L-AM1250600 |
| 600 | | 440L-AM0750750 | | 440L-AM1250750 |
| 720 / 840 | | 440L-AM0750900 | | 440L-AM1250900 |
| 960 | | 440L-AM0751050 | | 440L-AM1251050 |
| 1080 | | 440L-AM0751200 | | 440L-AM1251200 |
| 1200 | | 440L-AM0751350 | | 440L-AM1251350 |
| 1320 / 1440 | | 440L-AM0751500 | | 440L-AM1251500 |
| 1560 | | 440L-AM0751650 | | 440L-AM1251650 |
| 1680 | | 440L-AM0751800 | | 440L-AM1251800 |
| 1800 / 1920 | | None Available | | None Available |

*Table 7*

| ROCKWELL AUTOMATION Part No. | Description |
|---|---|
| 445L-AF6140 | Standard mounting kit (4 pieces) |
| 445L-AF6141 | Adjustable mounting kit |
| 445L-AF6142 | Shock mount kit |
| 445L-AF6144 | Mounting kit for POC AND Sick FGS adapter (4 pieces) |
| 445L-AF6150 | Optical Interface (incl. software) |

## 9. Inspection and service

All light curtains contain only electronics and therefore need limited preventive maintenance.

### 9.1. Cleaning

The optical windows are to be cleaned with non-aggressive materials only. The interval between cleaning is dependant on the operating environment at the installation.

**ATTENTION**
Do not use aggressive solvents or abrasive substances. Otherwise range reduction and false switching could arise.

### 9.2. Inspections

The light curtain must, depending on the valid regulations, be periodically tested by qualified and trained persons.

The function of the light curtain can be tested with the supplied test rod, which has a diameter corresponding to the resolution of the light curtain. The status is indicated through the LED display in the ROCKWELL AUTOMATION GuardShield Safe 4 light curtain.

**Functional Test**
The function of the light curtain can be tested using the test rod, (*Figure 12*), which has a diameter corresponding to the resolution of the light curtain. The status is displayed at the 3 LEDs at the transmitter and receiver. The status can be easily read from the trouble shooting labels “Transmitter Status” and “Receiver Status” (*table 1 and 2*, page 15).

### 9.3. Decommissioning

The safety light curtain may only be removed, if the machinery or assembly line will be closed definitively. This has to be done by removing the main supply from the machinery. It must be impossible to bring the machinery into operation without using tools.
The light curtain can be reused provided the current regulations are taken into consideration.

If the light curtain has to be disposed, it can easily be disassembled and recycled using state of the art recycling technology and following current disposal regulation. It does not contain harmful materials except small quantities of materials used in electronic PCBs.

## 10. Product labels

All relevant ratings are given on the 2 product labels. The labels are attached to the receiver as well as the transmitter light curtain.

## 11. Technical Data

*Table 8*

| Description | Value | Remarks |
|---|---|---|
| Protective heights | 120 mm to 1920mm | 120mm increments |
| Operating range | 0 ... 9 m<br>0 ...6m | Resolution 14 mm<br>Resolution 30 mm |
| Object detection capability (Resolution) | 14 mm<br>30 mm | |
| Power supply $U_{sp}$ | 24 VDC ± 20 % | PELV, IEC 60 204-1 |
| Power supply ripple | < 10 % of $U_{sp}$ | |
| Equipment Class | III | VDE 0106 part 100 |
| Time for self check when switching on $U_{sp}$ | < 3 s | |
| Current consumption | < 500 mA | No-load operation |
| Outputs, short circuit proof | 2 x PNP, 0.3 A | Max. capacitive load 0.5 µF |
| Output voltage | > $U_{sp}$ – 1 | Load 0.1 A |
| Response time $t_{R-BWS}$ | Selection table | Page 18 |
| Connector | M12 qd | |
| Connection cable | Max length 5 m<br>Cross section max. 1.5 $mm^2$ | |
| Outside diameter of cable | 3 ... 6.5 mm | for M12 |
| Mode of operation | Guard only with automatic restart | |
| Safety category | Type 4 | Self testing |
| Standards | IEC 61496 part1+2 | |
| Electromagnetic compatibility (EMC) | IEC 61 496 part 1 | |
| Enclosure rating | IP65 | |
| Temperature range | 0 ... +55°C<br>-20 ... +60°C | Operation with ILAS<br>Storage / transport |
| Relative air humidity | 15 ... 95 % | Non condensing |
| Enclosure | Aluminum profile 30 x 40 mm | |
| Optical window | Polycarbonate, bonded | |
| Enclosure treatment | Polyester powder coated | Silicon free manufactured |
| ILAS | Laser class 2 | EN 60 825 |
| Dimensions | Dimensions and selection tables | Page 17 + 18 |
| Weight | Selection tables | Page 18 |
| PAC operating range | 0 - 30m | 2 and 3 segments |

Please contact us for Technical Assistance:
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Outside U.S.: 001-440-646-5800
On line: http://www.ab.com/safety

**www.rockwellautomation.com** **http://www.ab.com/safety**

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